

Subject: Strategic importance of gravimeters  
re - export licence B-7-917-33821

1. Gravimeters or gravity meters are one type of instrument used to measure the relative variation in the acceleration of gravity on the earth from point to point. The other frequently-used instrument is the pendulum which has also the distinctive character of being usable for the measure of absolute value of gravity at any given point. Each type of instrument enjoys certain distinctive advantages. The pendulum yields observations that are generally more uniform, but are obtainable at the cost of (1) greater time required for observation and (2) difficulties in portability. The gravimeter, which measures sensitive variations in gravity by means of a delicate spring yields data that (1) can be observed in a fraction of the time required by a pendulum, and (2) can be transported easily from point to point. Gravimetric observations, however, are subject to accidental errors due chiefly to changes in pressure, temperature and other erratic effects on the delicate spring. These errors are generally referred to as the "drift." The drift varies not only among different instruments, but also for any given instrument from one set of conditions to another. This results in a degree of non-uniformity in data which necessitates (1) frequent calibration between instruments and, (2) frequent returning of a gravimeter from a given field station on a survey to a base station for which a base

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value has been established by numerous pendulum observations. This troublesome drift problem has put a premium on technologists to develop an instrument whose drift rate would be at a minimum.

While a number of firms in Europe and the US produce gravimeters the most satisfactory instrument developed to date is the Worden gravimeter, produced by Texas Instruments, Inc., at Houston. The gravimeter provides accuracy together with compactness, portability, and ease of operation in the field. As a result it enjoys deserved popularity through the world. To our knowledge it has not been obtained by the Soviet Bloc, Yugoslavia excepted. Because the vital parts are sealed in a cell, only the manufacturer can service the sensitive inner components. In this manner the manufacturer assures continuing performance. This, however, also protects his distinctive design by monitoring the required purchase agreements. To date there have been no known attempts to force the inner cell for copy of the design; also, it is possible to say that quite probably the Worden gravimeters have found their way to the Soviet Bloc, Yugoslavia excepted. This also makes it understandable why Mr. Worden is not desirous of selling his instrument to the Soviet Bloc. In contrast to this unique US technological capability, the Soviet Bloc has not been as successful in the production of gravimeters. We know that the Soviets are having difficulty with an excessive drift rate in their gravimeters.

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This has been reflected in (1) fruitless Soviet efforts to obtain US gravimeters under an exchange arrangement for their Arctic IGY program, (2) an attempt to purchase two Worden meters without the required restrictive agreement for servicing, and (3) an anxious attempt to arrange a calibration of US and Soviet gravimeters at a US station in Antarctica where gravimeter and pendulum values on the Fotsdam datum (the same Datum to which the Soviet gravity survey and network has been related) have been determined.

2. Gravity data are used primarily for resource exploration and for geodetic and mapping purposes. To this end the Soviet Union has completed a systematic general gravity survey of the USSR, in addition to numerous gravity surveys undertaken for mineral and fuel resource exploration. Moreover, we have information that effort is being stimulated in the Soviet Bloc, and the Soviet gravity net is being extended into Syria, Afghanistan, India, and other peripheral countries as a part of the Soviet aid program in geological mapping and resource exploration. It is significant to note that none of these data are permitted to be disseminated to the Free World. This has been explicitly established from Soviet IGY scientists on several separate occasions. This reluctance is not difficult to understand. The importance of gravity data from a military standpoint, stems from the fact that gravity studies provide the best method of determining the shape of the earth, that is, its flattening and its variations from a mathematical ellipsoid of rotation. Since gravity data can be collected

for the great oceanic expanses of the earth's surface inaccessible to triangulation, improvements in our knowledge of the earth's shape will come as we acquire more gravity data from all over the earth. The advent of the ICBM and the very demanding requirement for accuracy at the end of a 5500-6000 mile range necessitates a constant search for ways to reduce geodetic error at the target. It is also recognized that gravity anomalies at the surface extend into the earth's exterior gravity field and will influence the ICBM during flight. Preliminary studies so far indicate still a wide range of uncertainty regarding the gravity anomaly effect upon the ICBM during flight. Moreover, the Soviets have through an energetic adoption of gravimetric data to mapping purposes developed the capability to establish geodetic control adequate to satisfy the control requirements for mapping at scales of 1:100,000 for areas devoid of triangulation. Since many areas of the world have no adequate triangulation (and this includes extensive areas on the periphery of the Soviet Bloc and in China), the Soviets will be able after (1) the completion of a gravity survey, and (2) the collection of Free-World gravity data (which have generally been freely shared -- except for the commercially significant oil data of private oil companies) to significantly improve their target-locating accuracy at any point simply by obtaining an astronomic position and correcting it for deflections of the vertical. From this it is readily understandable why the Department of Defense has taken action to classify gravity data as secret.

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3. Since the IGY is concerned only with the observation of dynamic geophysical phenomena gravimetry is limited only to the recording of minute variations in the acceleration of gravity for the purposes of studying earth tides. For this purpose special ~~stationary~~ gravimeters are used that record changes in acceleration with time. One of the leading instruments is the LaCoste-Romberg earth tide gravimeter. Neither the earth tide program nor ~~extension procedures activities that are being~~ ~~actively undertaken~~ the instrument has any military significance. In fact, the earth tide program is one of the least emphasized of the dynamic disciplines in the IGY. In the US program it was not included in the initial budget at all, and subsequently has been covered only in part. 25X9A5 of California has been hard put to obtain a \$25,000 allocation for a second, required meter. Similarly, the USSR has only two stations at which earth tide observations are scheduled. There are, however, extensive gravimetric activities that are being actively undertaken. One part in connection with the glaciological studies in Antarctica for purposes of determining the thickness of the ice shield and the elevation of the rock understructure. Both the US and USSR are engaged in these observations. The other part of this program is wholly an adjunct activity having no substantive relationship to the IGY; this consists of an effort by a number of Free World countries to make gravity observations purely as an activity of opportunity by taking advantage of the presence of many scientists located over many points

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throughout the world for the IGY program. The data of these activities will not only be of initial scientific value but will ultimately have significant military application. In this connection it is most significant to observe Soviet maneuvers with respect to this discipline. It is necessary to recall that at the formal Soviet announcement of participation in the IGY made at Rome, September, 1954, the Soviet scientist made a plea for the expansion of IGY activity in gravimetry and seismology. Subsequent Soviet Bloc IGY plans disclose that neither the Soviets nor any other Bloc country has done anything to expand the program (except as noted in connection with glaciological activities in Antarctica). This means that while the data of numerous announced Free World adjunct gravimetric observations are committed to be shared with the Sino-Soviet Bloc, the Bloc countries have no similar announced program and therefore are under no obligation to share gravity data of past or future activities.

4. With the above facts as background it is now possible to evaluate the Polish request for two Worden gravimeters. The first attempt to purchase in 1956 was cancelled with the refusal for the issuance of an export license in August 1956. This was favorably received by Mr. Worden who has had no desire to export to the Bloc countries. The renewed Polish request of April 1957 incorporated the justification that their use was intended for the Polish IGY program. From paragraph 3 it is clear that there is no need for a Worden gravimeter for the IGY program, except in the Soviet

Antarctic glaciological program. Further analysis of currently available Polish announced plans indicated no Polish Antarctic program and no announced plan to undertake gravity observations in Spitzbergen -- even though the order for the gravimeters specified calibration adjustments for use in higher latitudes -- 40° to 80°. In view of this, if a Pole does participate in the Antarctic or Arctic it will be for the Soviets and not for the Polish program of studies. Polish gravity commitments to provide data only include three localities in Poland, one of these, Borowa Gora is the initial point for the Polish triangulation network which is now being integrated with the Soviet geodetic datum, and the other is at Borowies which has been established by the Soviets as a station for variation of latitude studies. It is further to be noted that the Polish order has been placed for the geodetic type gravimeter. In this connection it must be recognized that the Poland together with the other European Satellites, under Soviet edict, have been in process since 1952 of re-adjusting their national geodetic and mapping systems for unification with the Soviet system. In view of this any matters relative to geodesy and mapping must be presumed to be under Soviet domination. It is reasonable to conclude, therefore, that any geodetic type instrument is likely to fall into Russian hands. Moreover, from the above it is also clear that the burden of proof still remains upon the Poles to prove that the specific instruments are needed for the IGY. Moreover, as regards the gravimetric activities that are adjunct to the IGY program, the Poles ought to provide a convincing reason why a Worden meter is needed, whereas wither Askania or Norgoord

gravimeters could have been easily purchased in Europe. It is our view that this question provides the final clue to the conclusion that the Poles are seeking these Worden meters for the Soviet Union. With them the Soviets will be able to (1) copy the distinctive design of the Worden meter, and (2) calibrate their own instruments for the <sup>determination</sup> ~~derivation~~ of desirable correction factors to facilitate the <sup>collection</sup> ~~collection~~ of their own data with these collected from the Free World. This would substantially advance Soviet progress to a superior position in establishing a World gravimetric system. This superiority stems from the fact that Soviets have refused to release their gravity data on the Sino-Soviet Bloc areas.

5. The above summary reflects concern of the interdepartmental Informal Working Group on the IGY, made up of intelligence representatives of the Air Force, State and CIA. Initial concern is indicated in the minutes of the meeting of 1 May 1957:

Par. 2 Mr. Goodman ~~State~~ also drew attention to Dispatch 461, 15 April 1957, from the US Embassy Warsaw, reporting a request from the Poles for equipment, including gravity meters, for IGY use. The working group felt there was a possibility that this request represented an attempt by the Soviets to obtain through another channel gravimetric equipment previously denied them.

25X1A9a [redacted] undertook to arrange to draw the attention of the Department of Commerce to the undesirability of permitting export of this type of equipment to the Soviet Bloc.

This matter and concern was directed to the chairman of the Operating Committee, on 24 May 1957 who indicated that no export license was then



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outstanding. When it was pointed out that a re-application was likely, the Chairman observed that when such re-application would be considered by the Bureau of Foreign Commerce he would become aware of it and advise the CIA member. No information on the subsequent re-application was given to the CIA representative. When it was suddenly learned in October that a license had been granted <sup>in 1957</sup> to Poland the matter was again discussed by the Working Group and is further reflected briefly in the minutes of the meeting of 30 October 1957:

With respect to the Worden gravimeters destined for Poland, Mr. 25X1A9a

[redacted] cited a report that the Poles have stated the gravimeters will not be exported from Poland except to the Antarctic. Since Poland has no Antarctic expeditions, this statement increases the likelihood that the equipment is destined for USSR use. 25X1A9a [redacted] also reported that Worden had been approached by the Sharp Company of Toronto regarding export of gravimeters presumably to Communist China.

6. Recognizing the difficulty of a complete rejection of the Polish order, it is suggested that this negative action can be softened with a statement that a more suitable instrument for IXX observation is the LaCoste-Romberg earth tide recorder, which is available for purchase.